than 10^{15} cm^{-3}, less than about than 10^{16} cm^{-3}, less than about than 10^{17} cm^{-3}, less than about than 10^{18} cm^{-3}, or less than about than 10^{19} cm^{-3}. The compensatory dopant may be selected from at least V, Cr, Mo, W, Mn, Re, Fe, Ru, Os, Co, Rh, Ir, Ni, Pd, Pt, Cu, Ag, Au, Zn, Cd and Hg. In a preferred embodiment, the concentration of the compensatory dopant in the ammonothermally-grown crystalline group III metal nitride is greater than the sum of the concentrations of oxygen and silicon. The optical absorption coefficient of the ammonothermally-grown crystalline group III metal nitride at wavelengths between about 395 nm and about 460 nm may be less than about 10 cm^{-1}, less than about 5 cm^{-1}, less than about 2 cm^{-1}, less than about 1 cm^{-1}, less than about 0.5 cm^{-1}, less than about 0.2 cm^{-1}, or less than about 0.1 cm^{-1}.

By growing for a suitable period of time, the semi-insulating ammonothermally-grown crystalline group III metal nitride may have a thickness of greater than about 1 millimeter and a length, or diameter, greater than about 20 millimeters. In a preferred embodiment, the length is greater than about 50 millimeters or greater than about 100 millimeters. After growth, the ammonothermally-grown crystalline group III metal nitride may be sliced, polished, and chemical-mechanically polished according to methods that are known in the art to form one or more wafers or crystalline substrate members. In a preferred embodiment, the root-mean-square surface roughness of the at least one wafer or crystalline substrate member is less than about one nanometer, for example, as measured by atomic force microscopy over an area of at least about 10 micrometers by 10 micrometers.

The semi-insulating ammonothermally-grown crystalline group III metal nitride crystal, or a wafer sliced and polished from the crystal, may be used as a substrate for fabrication into optoelectronic and electronic devices such as at least one of a light emitting diode, a laser diode, a photodetector, an avalanche photodiode, a transistor, a rectifier, and a thyristor; one of a transistor, a rectifier, a Schottky rectifier, a thyristor, a p-i-n diode, a metal-semiconductor-metal diode, high-electron mobility transistor, a metal semiconductor field effect transistor, a metal oxide field effect transistor, a power metal oxide semiconductor field effect transistor, a power metal insulator semiconductor field effect transistor, a bipolar junction transistor, a metal insulator field effect transistor, a heterojunction bipolar transistor, a power insulated gate bipolar transistor, a power vertical junction field effect transistor, a cascade switch, an inner sub-band emitter, a quantum well infrared photodetector, a quantum dot infrared photodetector, a solar cell, and a diode for photoelectrochemical water splitting and hydrogen generation.

While the above is a full description of the specific embodiments, various modifications, alternative constructions and equivalents may be used. Therefore, the above description and illustrations should not be taken as limiting the scope of the present invention which is defined by the appended claims.

What is claimed is:

1. A bulk gallium-containing nitride crystal comprising:

a length greater than about 5 millimeters;

a wurtzite crystal structure;

a concentration of oxygen from about 10^{10} atoms per cubic centimeter to about 10^{17} atoms per cubic centimeter;

an impurity concentration greater than about 10^{15} cm^{-3} of at least one of Li, Na, K, Rb, Cs, Ca, F, and Cl;

a compensatory dopant selected from V, Cr, Mo, W, Mn, Re, Fe, Ru, Os, Co, Rh, Ir, Ni, Pd, Pt, Cu, Ag, Au, Zn, Cd, Hg, and a combination of any of the foregoing, wherein the concentration of the compensatory dopant is between about 10^{14} cm^{-3} and about 10^{16} cm^{-3};

an optical absorption coefficient less than about 10 cm^{-1} at wavelengths between about 395 nm and about 460 nm; and

an electrical resistivity at room temperature greater than about 10^{7} ohm-centimeter.

2. The gallium-containing nitride crystal of claim **1**, comprising an impurity concentration of oxygen less than about 10^{16} cm^{-3}.

3. The gallium-containing nitride crystal of claim **1**, comprising an impurity concentration of oxygen less than about 10^{15} cm^{-3}.

4. The gallium-containing nitride crystal of claim **1**, wherein the concentration of the compensatory dopants is less than about 10^{16} cm^{-3}.

5. The gallium-containing nitride crystal of claim **1**, wherein the optical absorption coefficient at wavelengths between about 395 nm and about 460 nm is less than about 2 cm^{-1}.

6. The gallium-containing nitride crystal of claim **1**, wherein the optical absorption coefficient at wavelengths between about 395 nm and about 460 nm is less than about 0.2 cm^{-1}.

7. The gallium-containing nitride crystal of claim **1**, wherein the gallium-containing nitride crystal has a thickness of greater than about 1 millimeter.

8. The gallium-containing nitride crystal of claim **7**, wherein the length is greater than about 20 millimeters.

9. The gallium-containing nitride crystal of claim **1**, wherein the length is greater than about 100 millimeters.

10. The gallium-containing nitride crystal of claim **1**, wherein the crystal is characterized by a crystallographic radius curvature of greater than 100 meters.

11. The gallium-containing nitride crystal of claim **1**, comprising a large-area surface characterized by-a root-mean-square surface roughness of 1 nanometer and less.

12. The gallium-containing nitride crystal of claim **11**, wherein the large-area surface has a crystallographic orientation within about 5 degrees of (0 0 0 ±1) c-plane.

13. The gallium-containing nitride crystal of claim **11**, wherein the large-area surface has a crystallographic orientation within about 5 degrees of (1 0 −1 0) m-plane.

14. A device comprising the gallium-containing nitride crystal of claim **1**, wherein the device is selected from a light emitting diode, a laser diode, a photodetector, an avalanche photodiode, a transistor, a rectifier, a thyristor; a transistor, a rectifier, a Schottky rectifier, a thyristor, a p-i-n diode, a metal-semiconductor-metal diode, high-electron mobility transistor, a metal semiconductor field effect transistor, a metal oxide field effect transistor, a power metal oxide semiconductor field effect transistor, a power metal insulator semiconductor field effect transistor, a bipolar junction transistor, a metal insulator field effect transistor, a heterojunction bipolar transistor, a power insulated gate bipolar transistor, a power vertical junction field effect transistor, a cascode switch, an inner sub-band emitter, a quantum well infrared photodetector, a quantum dot infrared photodetector, a solar cell, and a diode for photoelectrochemical water splitting and hydrogen generation.

15. The gallium-containing nitride crystal of claim **1**, wherein the electrical resistivity at room temperature is greater than about 10^{9} ohm-centimeter.

16. The gallium-containing nitride crystal of claim **1**, wherein the electrical resistivity at room temperature is greater than about 10^{11} ohm-centimeter.

17. The gallium-containing nitride crystal of claim **1**, comprising an oxygen content as a substitutional impurity less than about 10 parts per million.